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PROCEDURES MANUAL, DETROIT RIVER-LAKE ERIE PROJECT LABORATORY SECTION

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PROCEDURES MANUAL
DETROIT RIVER-LAKE ERIE PROJECT
LABORATORY SECTION

LABORATORY PROCEDURES

SAMPLE PRESERVATION

All bacteriological samples were iced after collection and were kept iced until analyzed. Time considerations specified in "Standard Methods"[1] were rigidly adhered to for bacteriological and chemical analyses.

All samples for chemical analyses were delivered to the laboratory in glass bottles. Samples were poured immediately upon receipt at the laboratory into glass or polyethylene bottles, and preservatives were added. The following will summarize the type of bottle, preservative used, and status after preservation.

Analyses	Bottle	Preservative	Status After Preservative
Mineral	Polyethylene	None	Stored at room temperature
Phenol	Polyethylene	Copper sulfate 1 gm/liter Phosphoric Acid to pH less than 4	Refrigerated Analysis within 24 hours
Cyanide	Polyethylene	Sodium Hydroxide to pH of 11	Stored at room temperature
Grease	Glass	Acidify to pH 1 with Hydrochloric acid	Stored at room temperature
Ammonia Compounds	Polyethylene	Same as Phenol	Stored at room temperature

SAMPLE HANDLING

When a sample was brought into the laboratory, it was assigned a number. The aquatic samplers noted on the laboratory sheet all pertinent information to describe the sample. After the laboratory sheets were filled out by the samplers, they poured the samples into an appropriate bottle and noted on the bottle the laboratory number. Thus, if sample was collected at Station R-88

for phenol analysis, cyanide analysis, mineral analysis, grease analysis and bacteriological analysis, a sampler would obtain the next laboratory sequential number, assign it to R-88 and note this number on the bacteriological bottle, on the polyethylene bottle containing copper sulfate, on the polyethylene bottle containing sodium hydroxide, on the polyethylene bottle with no preservative, and on the glass half-gallon bottle for grease analysis. After placing the bacteriological bottle on ice, the sampler would then pour the appropriate volumes into each of the bottles. When the pouring of all samples was completed, the sampler notified the chemists that the samples are ready for analysis. The chemist would then check his list of analyses required against bottles poured and would release the sampler.

The laboratory established a priority for analyses. Immediate attention was given to nitrite, nitrate, and chlorine residual analysis. If time permitted, phenol analysis were done on the same day. However, this was the exception and in the majority of instances those samples requiring phenol analysis were preserved and analyzed the next morning. Mineral analysis were next to be completed. Cyanide analysis and grease analysis were conducted on an accumulated number of samples. Ammonia nitrogen and organic nitrogen analysis were stored until at least ten samples were ready for analysis. All samples kept their identity with the assigned laboratory number. If a question arose as to the laboratory number because of a smudge mark, legibility, or any other doubt, the sample was discarded and no result was reported.

When the workload was lighter, all data was noted on the laboratory sheets. As the workload increased, it was deemed essential to use laboratory analysis books. One book was assigned to a particular analysis. The chemist noted in the book the date of analysis, the laboratory number, and the

laboratory result. The information from the laboratory books was then transferred onto the laboratory sheets.

All laboratory sheets were then checked by the chemists and turned over to the data evaluation section.

ANALYTICAL METHODS

The analytical methods used by the laboratory for physical and chemical analyses were the procedures published in "Standard Methods for the Examination of Water and Wastewater," 11th Edition, 1960 [1], referred to throughout this report as "Standard Methods" unless otherwise indicated.

Minor modifications have been made on some of the methods used to improve the sensitivity or to expedite a systematic analytical scheme. Before adopting any modification, a thorough study was made to evaluate the impact of the change. These modifications will be explained in detail, together with precision, accuracy, and recovery data on the change.

To assure continually reliable data, reference standards of known composition and blanks were analyzed simultaneously with all tests.

A summation of analyses performed is presented below. Where the tests conform strictly to "Standard Methods" only, pages where in the procedures may be found are cited.

Chemical Analyses

The following analyses were performed according to "Standard Methods".

Analyses	Technique	Pages
Acidity	Phenolphthalein acidity	42-43
Alkalinity	Potentiometric pH 4.5	44-47
Alkalinity	Potentiometric pH 8.3	44-47
Chloride	Mercuric Nitrate	79-81

Chemical Analyses (cont.)

Analyses	Technique	Pages
Conductance	Specific Conductance Cell	114-116
Cyanide	Serfass Distillation	350-358
Oxygen Demand Biochemical		318-323
Oxygen Demand Chemical	Silver Sulfate Catalyst	399-402
Oxygen Dissolved	Method A - Alsterberg (Azide) Modification of the Winkler Method	309-311
Grease		291-293
Nitrites		180-181
pH	Glass Electrode Method	194-197
Phenol	Aminoantipyrine	404-408
Phosphate	Total - Autoclaved with Sulfuric acid on unfiltered sample B - Stannous Chloride Method	202-205
Total Solids	Total Residue Porcelain dish	211-214
Total Volatile Solids	Total Volatile	327
Suspended Solids	Filterable residue Gooch crucible	214-215
Settleable Solids	Settleable matter by weight Gooch crucible	329-330
Volatile Suspended Solids	Volatile Suspended Matter	329
Turbidity	Jackson Candle	261-264

Methods Used With Modifications

A systematic analysis scheme was developed using the preservative qualities of copper sulfate and phosphoric acid.[2] The residue from the phenol analysis was used for ammonia nitrogen and organic nitrogen analyses.

After a literature study[3][4] and an extended study in the laboratory, it was determined that those ammonia nitrogen compounds that are converted to ammonium ions by the action of copper sulfate, phosphoric acid, and sodium hydroxide can be classified as readily available ammonia. This ammonia is not necessarily the same ammonia obtainable in the procedure found in "Standard Methods", pages 168-169. However, limited studies on river water, distilled water with ammonium compounds added, and on river water with ammonium compounds added gave the same results as the procedure found in "Standard Methods".

The complete procedure for ammonia nitrogen is as follows:

a. A 500-ml sample containing ammonia was preserved with one gram per liter copper sulfate, and pH was reduced to below a pH of 4 with phosphoric acid.

b. Volume of sample was reduced to 50 ml as a result of analysis for phenol.

c. A 100 ml of ammonia-free distilled water was added to the reduced volume sample.

d. Sodium hydroxide (250 grams per liter) solution was added to the sample until copper hydroxide precipitate forms.

e. Sample was distilled in an all-glass distillation apparatus collecting 100-ml distillate.

f. An aliquot of the distillate was determined colorimetrically using Nessler's reagent as found in "Standard Methods", pages 170-172.

Organic Nitrogen

The organic nitrogen was analyzed according to "Standard Methods",

pages 305-306, with the modification of substituting copper sulfate and phosphoric acid as catalyst for mercuric sulfate (5)(6).

Nitrate Nitrogen

Nitrate nitrogen analyses were performed according to "Standard Methods", using the tentative Brucine method found on pages 178-179, using 10 ml of sample instead of 2 ml of sample.

During the normal sampling periods, duplicate and triplicate analysis were performed on a variety of samples. Mean results were reported on data sheets. All samples which gave extremely high or extremely low values were rechecked.

Included below are some typical values obtained in triplicate for dissolved oxygen, total solids, chemical oxygen demand, and suspended solids analysis.

TABLE I. DISSOLVED OXYGEN
ppm

Sample Source	1	2	3	Mean
River Composite	6.5	6.45	6.45	6.5
River Composite	7.15	7.15	7.15	7.2
River Composite	8.3	8.3	8.3	8.3
River Composite	8.9	8.85	8.8	8.9
River Composite	9.1	9.05	9.0	9.1
River Composite	9.3	9.4	9.3	9.3

TABLE II. TOTAL SOLIDS
ppm

Sample Source	1	2	3	Mean
W50	190	180	190	190
W150	350	350	350	350
Monguagon Creek	460	450	450	450
W54	650	640	670	650

TABLE III. CHEMICAL OXYGEN DEMAND
ppm

Sample Source	1	2	3	Mean
W115	25	19	22	22
W114	25	26	22	24
W113	37	34	34	35
W118	183	178	199	187
W165	384	355	355	365

TABLE IV. SUSPENDED SOLIDS
ppm

Sample Source	1	2	3	Mean
W53	6	1	1	3
T-85	23	17	27	22
R-155	36	33	37	35

TABLE IV. SUSPENDED SOLIDS – (Cont.)

Sample Source	1	2	3	Mean
W56	48	36	47	44
W165	112	93	116	107
W132	294	282	284	287
W27	621	649	612	627
W111	883	615	757	752
W24	4,204	4,098	4,168	4,156

ANALYTICAL PROCEDURES FOR BACTERIOLOGICAL EXAMINATION OF WATER SAMPLES

All water samples collected for bacterial study were examined for total coliform content, using the Millipore Filter (MF) technique as described in Standard Methods for Examination of Water and Wastewater, Eleventh Edition (1). The Most Probable Number (MPN) test for total coliforms was performed as described in Standard Methods (1). Lauryl sulfate tryptose broth was used for the presumptive test. The MPN test was used only as an occasional check against the MF technique.

Fecal coliform and fecal streptococci tests were made as necessity indicated. The streptococci determinations were made using the MF techniques as described in Standard Methods (1). KF Streptococcus Agar (Difco No. 0496-01) was used in place of M-enterococcus Agar.

An estimate of the fecal coliform population was reached by inoculating sheen colonies from the total MF plates directly into fermentation tubes of [illegible] Medium (Difco No. 0314-01), one colony per tube of medium with incubation in a water bath set at [illegible]5 - 45°C for 24 (±2) hours ( ). The number of colonies picked ranged from 10 to 20 per sample. If 10 colonies were picked and none were positive, the result was recorded as "< 10%." If none of 20 colonies were positive, the result was recorded as "< 5%." A zero per cent was never recorded. This test is termed a temperature differential test. The presence of gas in the fermentation tubes indicates the coliforms present originated from the gut of warm-blooded animals (fecal coliforms). Absence of gas indicates the absence of fecal coliforms

since coliforms derived from non-fecal sources generally fail to produce gas at 44.5 - 45°C.[7] Recommendations for the standardization of techniques were made by Mr. H. F. Clark of the Robert A. Taft Engineering Center with regard to procedures, preparation of media, incubation of cultures, and tabulation of results.

REFERENCES

1. American Public Health Association, Standard Methods for the Examination of Water and Wastewater. 11th Edition. American Public Health Association. New York. 1960.

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6. Allport, W.L., Keyser, J.W. Determinations of Clinical and Biochemical Significance. Colorimetric Analysis. Volume I. Chapman & Hall Ltd. London. 1957.

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PRECISION-ACCURACY-RECOVERY

Precision is defined as a measure of the reproducibility of a method when a number of replicates are analyzed under controlled conditions. Accuracy is the determination of the error of a method when a result of a known standard is compared against other known standards. Recovery is the quantitative recovering of a known amount of substance added.

Precision, accuracy, and recovery determinations were made on phenol, ammonia nitrogen, organic nitrogen and chlorides.

Precision and accuracy testing were performed on nitrates, total phosphates, and nitrites.

Bacteriological examinations were subjected to biochemical and microscopic testing on occasion to verify techniques. Colonies from the membrane filter were verified by biochemical and microscopic tests and positive fermentation tubes were also verified by biochemical and microscopic tests. Bacteriological precision determinations were run on waters of various qualities with the Membrane Filter Technique and the Multiple Dilution Technique.

Table I is a summation of precision and recovery determinations on phenol. A six-gallon portion of water from the river or a tributary was brought into the laboratory. Each sample was well mixed and divided into two five-liter portions for phenol and into similar smaller portions for the other tests. The one five-liter portion was poured into ten polyethylene bottles containing copper sulfate and phosphoric acid. A concentrated phenol solution of no greater volume than 50 ml was added to the second portion and this was poured into polyethylene bottles containing the above preservative. The twenty samples were then refrigerated and analyzed within 24 hours of

collection. The same personnel poured these samples that would normally perform this function during the regular sampling runs.

TABLE 1. PHENOL PRECISION - RECOVERY

Lab No.	Station	Feet from West Shore	Number of Replicates	Mean Conc. ppb	Standard Deviation	Amount Added	Number of Replicates	Mean Conc. ppb	Standard Deviation	% Recovered
7657	DT 8.7W	30	10	18	± 2	21	10	38	± 6	95
7660	Rouge River at Jefferson Avenue		10	201	± 20	121	10	339	± 19	108
7662	DT 26.8W	-	10	3	± 1	63	10	66	± 4	100
7667	DT 12.0W	122	10	7	± 1	32	10	38	± 2	97
7670	DT 26.8W	-	10	3	± 1	30	10	29	± 2	88
7671	DT 12.0W	-	10	13	± 2	30	10	39	± 2	91
7672	DT 26.8W	-	10	1	± 1	30	10	31	± 1	100
7673	DT 12.0W	490	10	9	± 1	50	10	53	± 3	90
7685	DT 12.0W	490	10	12	± 2	30	10	38	± 2	91

In Table II, a comparison of precision from replicate analysis and a measure of accuracy from a known concentration of standards is shown.

TABLE II. PRECISION - ACCURACY

Phenol Level ppb	Precision Number of Replicates	Pooled Standard Deviation	Number of Standards Compared	Root Mean Square Deviation from Known
0 - 20	80	± 1	37	± 2
30 - 70	80	± 3	37	± 6
100 - 300	20	± 20	37	± 8

Tables III and IV are summaries of precision determinations for ammonia and organic nitrogen analysis. The collection pouring and preservation of samples was the same as that for phenol analysis.

TABLE III. AMMONIA NITROGEN PRECISION

Lab. No.	Station	Feet from West Shore	Number of Replicates	Mean Conc. ppm	Deviation
7687	DT 12.0W	490	10	.46	.03
7688	DT 8.7W	680	7	.33	.02
7689	DT 12.0W	490	7	.38	.02
7690	DT 8.7W	680	9	.39	.01
7691	DT 12.0W	490	10	.41	.03
7692	DT 8.7W	680	10	.34	.02
7687(a)	DT 12.0W	490	9	.16	.04
7688(a)	DT 8.7W	680	7	.40	.02
7689(b)	DT 12.0W	490	10	.32	.03
7690(b)	DT 8.7W	680	8	.32	.03
7691(c)	DT 12.0W	490	10	.47	.03
7692(c)	DT 8.7W	680	10	.43	.04
D.W.			8	.15	.01

(a) - Samples were stored at room temperature with no preservative added for a period in excess of 72 hours, and a .33 milligram per liter solution of inorganic and organic nitrogen compounds were added to five liters of sample.

(b) - Samples stored at room temperature with no preservative added for a period in excess of 48 hours, and a .33 milligram per liter solution of inorganic and organic nitrogen compounds were added to five liters of sample.

(c) - Sample was preserved with copper sulfate and phosphoric acid and a .33 milligram per liter solution of inorganic and organic nitrogen compounds were added to five liters of sample.

D.W. is the designation used for distilled water.

TABLE IV. ORGANIC NITROGEN
PRECISION

Lab. No.	Station	Feet from West Shore	Number of Replicates	Mean Conc. ppm	Standard Deviation
7687	DT 12.0W	490	8	.19	.02
7688	DT 8.7W	680	7	.25	.09
7689	DT 12.0W	490	6	.12	.03
7690	DT 8.7W	680	5	.11	.02
7691	DT 12.0W	490	7	.09	.03
7692	DT 8.7W	680	6	.09	.03
7687(a)	DT 12.0W	490	8	.20	.03
7688(a)	DT 8.7W	680	8	.22	.05
7689(b)	DT 12.0W	490	9	.21	.03
7690(b)	DT 8.7W	680	8	.29	.09
7691(c)	DT 12.0W	490	6	.56	.06
7692(c)	DT 8.7W	680	5	.22	.04
D.W.			8	.18	.07

(a) - Samples were stored at room temperature with no preservative added for a period in excess of 72 hours, and a .33 milligram per liter solution of inorganic and organic nitrogen compounds were added to five liters of sample.

(b) - Samples stored at room temperature with no preservative added for a period in excess of 48 hours, and a .33 milligram per liter solution of inorganic and organic nitrogen compounds were added to five liters of sample.

(c) - Sample was preserved with copper sulfate and phosphoric acid and a .33 milligram per liter solution of inorganic and organic nitrogen compounds were added to five liters of sample.

D.W. is the designation used for distilled water.

Table V illustrates the need for preservation of samples for ammonia and organic nitrogen analysis.

TABLE V. TOTAL NITROGEN RECOVERED

Lab. No.	Station	Feet from West Shore	Mean Conc. ppm	Amount Added ppm	Recovered ppm	% Recovered
7687(a)	DT 12.0W	490	.65	.33	.36	.37
7688(a)	DT 8.7W	680	.58	.33	.62	.68
7689(b)	DT 12.0W	490	.50	.33	.53	.64
7690(b)	DT 8.7W	680	.50	.33	.61	73
7691(c)	DT 12.0W	490	.50	.33	1.03	124
7692(c)	DT 8.7W	680	.43	.33	.65	86
D.W.			0	.33	.33	100

(a) - Samples were stored at room temperature with no preservative added for a period in excess of 72 hours, and a .33 milligram per liter solution of inorganic and organic nitrogen compounds were added to five liters of sample.

(b) - Samples stored at room temperature with no preservative added for a period in excess of 48 hours, and a .33 milligram per liter solution of inorganic and organic nitrogen compounds were added to five liters of sample.

(c) - Sample was preserved with copper sulfate and phosphoric acid and a .33 milligram per liter solution of inorganic and organic nitrogen compounds were added to five liters of sample.

D.W. is the designation used for distilled water.

A summary of precision and accuracy is presented in Table VI.

Care should be used in interpreting data for ammonia nitrogen and organic nitrogen where values are in the level of 0.01 to 0.1 ppm because the reagents and ammonia-free water may approach or slightly exceed 0.01 mg/l concentrations.

TABLE VI. AMMONIA - NITROGEN PRECISION ACCURACY

Level ppm	Number of Replicates	Pooled Standard Deviation	Standard Deviation %	Level mg	Number of Standards	Root Mean Square Deviation from Known	Standard Deviation %	Standards Methods
0 - .2	17	.03	15	0.01 - .0125	19	.003	15	± 5%
.3 - .5	98	.03	6	0.02 - 0.05	40	.004	8	± 5%
.6 - .8	-	-	-	0.06 - .075	19	.005	6	± 5%
				0.08 - 0.1	11	.003	4	± 5%

Table VII is a comparison of the two methods for determining ammonia nitrogen. Other individual samples were compared using both techniques but this is a replicate comparison on one sample.

TABLE VII. COMPARISON OF AMMONIA DETERMINATION BY DISTILLATION FROM PHOSPHATE BUFFER WITH DISTILLATION FROM A SAMPLE PRESERVED BY COPPER SULFATE PHOSPHORIC ACID AND TREATED WITH ALKALI

	Number of Replicates	Mean Conc. ppm	Standard Deviation
Phosphate Buffer	6	.12	.02
$CuSO_4$-H_2PO_4 NaOH	10	.12	.02

Precision, recovery and accuracy on chloride analysis is presented in Tables VIII, IX, and X. All values for chloride analysis were rounded off to the whole number; thus, in some instances, the standard deviation was much less than one part per million or 0.1 mg since in about 95% of our work one hundred milliliters was the sample size.

TABLE VIII. CHLORIDES - PRECISION

Lab. No.	Station	Feet from West Shore		Number of Replicates	Mean Concentration ppm	Standard Deviation
7657	DT 8.7W	980	10	10	41	d
7660	Rouge River at Jefferson Avenue			10	27	d
7662	DT 26.8W	-		10	8	d
7667	DT 12.0W	122		10	39	1
7668	DT Mo 12.2			10	567	1
7670	DT 26.8W	-		10	7	d
7671	DT 12.0W	-		10	25	1
7672	DT 26.8	-		10	6	d
7673	DT 12.0W	490		10	48	1
7685	DT 12.0W	490		10	26	1
Composite	river and lake			10	48	1
Composite	river and lake			10	29	1

d - Standard Deviation less than 1 ppm

TABLE IX. CHLORIDES - PRECISION - RECOVERY

Sample Source	Station	Number of Replicates	Mean Conc. ppm	Standard Deviation	Amount Added	Mean Conc.	% Recovered
Composite	river and lake	10	48	1	5	53	100
Composite	river and lake	10	29	1	5	33	100

TABLE X. CHLORIDES - PRECISION - ACCURACY

Level ppm	Number of Replicates	Standard Deviation Pooled	Number of Standards	Pooled Root Mean Square Deviation from Known	"Standard Methods"
0-500	120	1	40	1	6*

* At 219 ppm level 6 ppm

Analyses for nitrate were conducted immediately on receipt of sample and Tables XI and XII summarize information on precision and accuracy.

TABLE XI. NITRATE PRECISION

Lab. No.	Station	Feet from West Shore	Number of Replicates	Mean Concentration ppm	Standard Deviation
7657	DT 8.7W	980	10	.29	.04
7660	Rouge River at Jefferson Avenue		10	.44	.12
7662	DT 26.8W	-	10	.19	.02
7667	DT 12.0W	122	10	.20	.01
7668	DT Mo 12.2		9	.80	.04
7670	DT 26.8W	-	7	.88	.16
7671	DT 12.0W	-	9	.10	.04
7672	DT 26.8W	-	10	.43	.05
7673	DT 12.0W	490	10	.16	.02
7685	DT 12.0W	490	10	.23	.04

TABLE XII. NITRATE PRECISION - ACCURACY

Level ppm	Number of Replicates	Pooled Standard Deviation	Number of Standards	Root Mean Square Deviation from Known
.30	49	.03	53	.05
.4 - .7	30	.08	52	0.1
.8 - 1.5	16	.11	51	0.16

Phosphate analysis information on precision and accuracy is presented in Tables XIII and XIV.

TABLE XIII. PHOSPHATES PRECISION

Lab. No.	Station	Feet from West Shore	Number of Replicates	Mean Concentration ppm	Standard Deviation
7657	DT 8.7W	980	9	.32	.03
7660	Rouge River at Jefferson Avenue		10	.05	.001
7662	DT 26.8W	-	10	.07	.03
7667	DT 12.0W	122	9	.18	.01
7668	DT Mo 12.2		10	.62	.04
7670	DT 26.8W	-	10	.03	.01
7671	DT 12.0W	-	10	.30	.02
7672	DT 26.8W	-	10	.02	.02
7673	DT 12.0W	490	10	.19	.01
7685	[illegible] 12.0W	490	10	.68	.04

TABLE XIV. PHOSPHATE PRECISION - ACCURACY

Level ppm	Number of Replicates	Pooled Standard Deviation	% Standard Deviation	Number of Standards	Root Mean Square Deviation from Known	% Standard Deviation	Standard Method Phosphate
0 to .1	40	.02	20	40	.01	10	± 2%
.15 to .40	38	.02	5	21	.02	5	± 2%
.5 to .7	20	.04	6	20	.02	3	± 2%
1.	-	-		22	.04	3	± 2%

Nitrite analysis also received immediate attention. The data on nitrite precision and accuracy is shown in Tables XV and XVI.

TABLE XV. NITRITES PRECISION

Lab No.	Station	Feet from West Shore	Number of Replicates	Mean Concentration ppm	Deviation
7657	DT 8.7W	980	10	.003	.0002
7660	Rouge River at Jefferson Avenue		10	.020	.002
7662	DT 26.8W	-	10	.002	.0002
7667	DT 12.0W	122	10	.003	.0002
7668	DT Mo 12.2		10	.018	.0004
7670	DT 26.8	-	10	.003	.001
7671	DT 12.0W	-	10	.004	.001
7672	DT 26.8	-	10	.002	.001
7673	DT 12.0W	490	10	.002	
7685	DT 12.0W	490	10	.008	.001

TABLE XVI. NITRITES PRECISION - ACCURACY

Level	Precision	Root Mean Square Deviation from Known	Standard Methods
0 0.025	.001	.004	.002

Precision determination for suspended solids at two levels is presented in Table XVII.

TABLE XVII. SUSPENDED SOLIDS PRECISION

Sample	Station	Number of Replicates	Mean Concentration ppm	Standard Deviation
T 31		10	19	4
Composite	Industrial Wastes	9	418	42

Table XVIII is the precision data for dissolved oxygen on aerated, buffered, seeded distilled water.

TABLE XVIII. DISSOLVED OXYGEN PRECISION

Sample	Station	Number of Replicates	Mean Concentration ppm	Standard Deviation
Seeded Buffered Distilled Water	Aerated Composite	11	7.00	.05
Seeded Buffered Distilled Water	Aerated Composite	16	7.45	0.1

Coliform replicate data by the Membrane Filter Technique is presented in Table XIX.

TABLE XIX. COLIFORMS - MEMBRANE FILTER

Sample No.	Station	Feet from West Shore	Number of Replicates	Log Mean	Log Mean + 2S	Log Mean - 2S	Range of Observed Value		Mean
							High Value	Low Value	
7669	USNAS S.T.P.		10	3,200,000	4,960,000	2,150,000	4,300,000	2,400,000	3,300,000
7674	DT 12.0W	490	10	130	1,660	63	300	40	150
7677	DT 12.0W	490	10	350	660	190	900	280	370
7681	USNAS S.T.P.		10	7,990,000	10,700,000	5,970,000	9,900,000	6,300,000	8,070,000
7682	DT 12.0W	490	10	25,900	48,800	13,700	44,000	16,000	27,200
7684	DT 12.0W	490	10	4,770	6,490	3,500	5,700	3,400	4,800
7686	DT 12.0W	490	10	350	750	270	600	180	320
7693	DT 12.0W	490	10	660	800	540	1,940	340	800
7708	DT 12.0W	490	10	1,520	1,970	1,170	1,700	1,120	1,520

Coliform replicate data by the Multiple Tube Dilution Technique is presented in Table XX.

TABLE XX. COLIFORMS - MULTIPLE TUBE DILUTION -
MOST PROBABLE NUMBER FIVE TUBES, THREE DILUTION

Sample No.	Station	Feet from Shore	Number of Replicates	Log Mean	Log Mean + 2S	Log Mean - 2S	Range of Observed Values		Mean
							High Value	Low Value	
7669	USNAS	S.T.P.	10	4,530,000	7,250,000	1,820,000	7,000,000	2,300,000	3,860,000
7674	DT 12.0W	490	10	620	2,150	180	1,300	230	740
7677	DT 12.0W	490	10	820	3,170	210	3,480	330	1,060
7681	USNAS	S.T.P.	10	8,460,000	12,100,000	5,900,000	24,000,000	3,300,000	9,970,000
7682	DT 12.0W	490	10	23,000	78,800	6,830	79,000	7,900	27,900
7684	DT 12.0W	490	10	11,000	60,000	2,000	39,000	7,000	13,900
7686	DT 12.0W	490	10	750	1,400	410	1,720	220	890
7693	DT 12.0W	490	10	1,100	2,600	610	3,480	310	1,470
7708	DT 12.0W	490	10	2,270	10,400	500	5,420	1,090	2,580

Inspection of Tables XIX and XX will reveal that there is more uniformity in the membrane filter technique.